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PLATE XI.

FIG. 11. *Tipula carinata*, lateral view of end of abdomen.
FIG. 12. *Dicranomyia venusta*, ninth sternum and appendage.
FIG. 13. *Tipula acuta*, ninth sternum.
FIG. 14. *Dicranomyia venusta*, lateral view of end of abdomen.
FIG. 15. *Symplecta punctipennis*, lateral view of end of abdomen.
FIG. 16. *Tipula bicornis*, ninth sternum.
FIG. 17. *Limnophila sciophila*, lateral view of end of abdomen.
FIG. 18. *Epiphragma forcipennis*, lateral view of end of abdomen.
FIG. 19. *Tipula streptocera*, ninth sternum.
FIG. 20. *Ptychoptera lenis*, lateral view of end of abdomen.

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NOTES ON THE INTERNAL ANATOMY OF PERANABRUS SCABRICOLLIS (*THOM.*).

BY ROBERT E. SNODGRASS.

(PLATES XII AND XIII.)

Peranabrus scabricollis (Thom.) is a large, thick-bodied, short-legged locustid inhabiting the central part of the State of Washington. The writer has already prepared an account of its interesting life-history to be published as a bulletin of the Washington Experiment Station under the name of the "Coulee Cricket."

The Alimentary Canal (Fig. 13) has the ordinary *Anabrus* form. The crop is large, extending back to the posterior edge of the thorax. The ventriculus and small intestine form a complete dorsal loop. The numerous, thread-like Malpighian tubules are grouped in six bunches. The gastric cæca (*gas. c.*) are two wide pouches embracing the posterior end of the crop.

The Salivary Glands (Fig. 4) are composed of groups of racemose glands in the ventral part of the thorax. The scattered groups (*s. gls.*) on each side are connected by ducts which finally form one main tube (*s. d.*). Into this opens the duct from the large sac-like reservoir (*s. r.*) of the same side. The final right and left ducts then unite in a median duct that opens at the base of the hypopharynx.

The Respiratory System is highly developed and all of the main tracheæ are large. The dorsal longitudinal trunks (Fig. 12, *d. l. tr.*) lie just at the edges of the diaphragm. Each is connected with the spiracle trunks of same side by two transverse tubes (Fig. 12, *t. tr.*). The anterior one of each pair is larger than the other.

The Nervous System (Figs. 1 and 3) consists of six abdominal ganglia, three thoracic, and the usual two head ganglia.

The brain (Fig. 1) is not composed of distinct lobes as it is in Acrididæ (*Dissosteira*). The procerebral, dentocerebral and tritocerebral parts on each side form one continuous mass thick above (*op. l.*) but gradually tapering downward into the circumœsophageal commissure (*cœ. c.*). The optic lobe regions (*op. l.*) are broadly united mesially and from their outer upper aspects give off the optic nerves or optic ganglia (*op. gl.*). Each of the latter is thickened basally, constricted beyond the middle, and swollen terminally where it abuts against the eye. The optic ganglia are much smaller than in the much larger-eyed Acrididæ. The ocellar nerves (*oc.*) are short and slender. The antennal nerves (*ant. n.*) arise from the upper part of the dentocerebral regions. The labral nerve (*l. n.*) and frontal commissure (*f. c.*) have a common basal trunk on each side, but the labral nerve soon separates, and goes downward to the labrum. From the frontal ganglion (*f. g.*) there goes ventrally upon the front of the œsophagus a slender œsophageal nerve (*œ. n.*), and posteriorly upon the dorsal surface of the crop a thicker stomatogastric nerve (*sg. n.*). The œsophageal commissure (*œ. c.*) arises on each side just before the bases of the circumœsophageal trunks (*cœ. c.*).

The subœsophageal ganglion (Fig. 3) is of ordinary form and gives off the mouth-part nerves as shown in the figure.

The three thoracic ganglia are situated one in each segment.

Of the six abdominal ganglia the first two are in the first and second segments respectively, the third is in the fourth segment, the fourth in the fifth, the fifth in the seventh, and the sixth in the eighth.

The Circulatory System (Figs. 9, 10 and 12) is rather easily studied on account of the large size of the specimens. The heart consists of a tube reaching from the posterior end of the abdomen forward into the head. In each abdominal segment it presents a fusiform enlargement or chamber (Fig. 12, *ht.* and *ao.*).

The diaphragm extends throughout the entire length of the dorsal part of the body, *i. e.*, from the anterior edge of the prothorax to the tip of the suranal plate (Fig. 12, *dp.*). In the thorax it is a wide sheet with slightly concave margins. It is widest in the prothorax, tapering posteriorly in the meso- and metathorax. In the anterior half of the abdomen it is a little wider than in the mesothorax, but back of this it gradually tapers posteriorly, ending in a point beneath the suranal plate.

The two dorsal longitudinal tracheal trunks lie just above the edges of the diaphragm (Fig. 12, *d. l. tr.*). The paired transverse commissures (*t. tr.*) join the longitudinal trunks at the middle of each segment from the first to the ninth. In the tenth segment there is only one transverse trachea on each side.

The diaphragm muscles (Fig. 12, *dp. m.*) are fan-shaped bundles of fibers that diverge upon the diaphragm from the anterior edges of the terga between each two pairs of transverse tracheæ. After entering upon the diaphragm the muscles break up into minute fibrillæ (Fig. 9) that cross and are interwoven in all directions, so that one individual fiber cannot be followed. In many cases the muscle appears to end after breaking up into fine hair-like bunches of spreading fibrillæ (Fig. 10).

The diaphragm is an almost invisible membrane but its presence is indicated by its numerous nuclei (Figs. 9 and 10, *d. n.*). The membrane itself, however, can be seen between the muscle fibers oι the fan-shaped bundles. Mesially the diaphragm is imperforate, but laterally it is fenestrated by numerous large and small oval holes (Fig. 9). In *Dissosteira* it is everywhere imperforate and is, in this form, much more plainly visible than in *Peranabrus* because the muscle fibers on it are not so numerous and do not break up into a felt-work of fibrillæ. Fig. 10 is a detailed copy of a small piece of the perforated part of the diaphragm. Several fenestræ are shown with the muscle bundles splitting and going around them as diverging groups of fibrillæ. The latter are seen in several places disappearing by becoming lost in a felt-work of fibers. The diaphragm nuclei (*d. n.*) are seen irregularly scattered about. In *Dissosteira* the muscle fibers extend continuously across the diaphragm from one side to the other, or branch and unite mesially in only a very simple plexus. They are further in *Dissosteira*, not distributed upon the diaphragm in fan-shaped bundles but arise serially or in small groups along the edge of the diaphragm and extend mostly straight across its surface.

In *Peranabrus* the muscle fibers appear to be unstriated. In *Dissosteira* they are distinctly striated. In the crayfish (*Astacus*) the floor of the pericardium is composed of an upper and a lower nucleated membrane inclosing a layer of transverse striated muscle fibers. Mesially the fibers break up into unstriated fibrillæ but these can be traced across directly into the fibers of the opposite side.

The upper surface of the diaphragm is covered by a layer of small, granular pericardial cells. The pericardial space above is filled by a loose mass of pericardial fat cells.

The Reproductive Organs occupy the usual positions above and below the alimentary canal.

In the male (Figs. 2 and 8) the testes (Fig. 8, *tes.*) are flat, oval and set on edge against the side wall of the body cavity, reaching from the front part of the fourth into the seventh abdominal segment. Four large tracheal trunks, from the spiracles of the third, fourth, fifth and sixth abdominal segments ramify in finger-like bunches upon the inner surface of each. Each testis is a racemose gland, not composed of tubes as in *Dissosteira*, and the vas deferens issues from its lower end. The latter, just below the testis, is tightly coiled into a solid, epididymis-like mass (Figs. 2 and 8, *epd.* The epididymis is uncoiled on the right side of Fig. 2).

Below the epididymis the vas deferens turns inward and is lost in the mass of accessory glands (Fig. 8, *ac. gls.*). When the posterior smaller ones of these are removed (as in Fig. 2) it is seen that the vasa deferentia enlarge greatly before uniting to form the ejaculatory duct (*ej. d.*). There are two sets of accessory glands. One set consists of two anterior lateral masses (*ac. gls.*) of long coiled tubes, those of each mass uniting posteriorly in a short tube (Fig. 2) which opens into the enlarged part of the vas deferens. The other set consists of a great number of smaller tubes (*ac. gls.'*) opening directly into the enlarged parts of the vasa deferentia. These glands must secrete the large mass of albuminous matter injected by the male into the bursa copulatrix of the female at the completion of copulation.

The spermatozoa are filiform with an anterior enlargement showing a constriction near the front end (Fig. 5). They occur in fan-shaped or conical bunches in the testes. In the spermatophores they form long feather-like bundles (Fig. 6), the shafts of which are formed by the united heads of the spermatozoa.

The penis (Fig. 11, *pen.*) consists of an irregularly lobed evagination from the anterior end of the genital chamber (*g. c.*). On its dorsal surface is an invagination, the spermatic pouch (*s. p.*), into which opens the ejaculatory duct. Above the base of the penis there arises from the anterior wall of the genital chamber two slender serrated, chitinous rods (*r.*).

In the female organs (Fig. 7) the ovaries (*ov.*) consist of two large oval masses of egg tubes, about fifteen tubes in each, lying in the upper lateral parts of the abdominal cavity from the first to the seventh segments. The tubes converge posteriorly and open together into the upper ends of the oviducts (*od.*), not serially along the sides of the oviducts as in *Dissosteira*. The vagina is very short and opens into the genital chamber above the anterior end of the eighth sternum.

The spermatheca (*spt.*) is an oval sac opening by a narrow neck into the dorsal wall of the genital chamber just back of the opening of the oviduct. A long coiled tubular gland (*gl.*) lies on the right side of he rectum and opens posteriorly between the bases of the gonapophyses.

The spermatophores are large, globular, chitinous capsules, about 2.25 mm. in diameter, of a yellowish color, and having a long slender, tapering, curved neck. Each is filled with a mass of the feather-like bundles of spermatozoa (Fig. 6) already described. The spermatheca contains only a few spermatophores — five in the specimens examined, and these are imbedded in an albuminous mass within it.

EXPLANATION OF THE PLATES.

PLATE XII.

Fig. 1. Anterior view of the brain. *ant. n.*, antennal nerve; *cœ. c.*, circumœsophageal commissure; *f. c.*, frontal commissure; *f. g.*, frontal ganglion; *l. n.*, labral nerve; *oc.* ocellar nerves; *œ. c.*, œsophageal commissure; *œ. n.*, œsophageal nerve; *op. gl.*, optic ganglion; *op. l.*, optic lobe; *sg. n.*, stomatogastric nerve.

Fig. 2. A part of the male reproductive organs, the testes and the smaller accessory glands (*ac. gls'.* of Fig. 8) removed, also the right epididymis partially unwound. *ac. gls.*, larger accessory glands; *ej. d.*, ejaculatory duct; *epd.*, epididymis; *vd.*, vas deferens.

Fig. 3. Subœsophageal ganglion, left side. *cœ. c.*, circumœsophageal commissure; *lab. n.*, labial nerve; *md. n.*, maxillary nerve; *mx. n.*, maxillary nerve; *p. c.*, posterior commissure.

Fig. 4. Salivary glands and reservoir of one side. *s. d.*, salivary duct of one side; *s. gls.*, salivary glands; *s. r.*, salivary reservoir.

Fig. 5. A mature spermatozoön from the testis.

Fig. 6. A feather-like bundle of spermatozoa from a spermatophore.

Fig. 7. Female reproductive organs, dorsal view. *gl.*, a tubular gland opening into the bursa copulatrix back of the spermathecal orifice; *od.*, oviduct; *ov.*, ovaries; *spt.*, spermatheca.

Fig. 8. Male reproductive organs, dorsal view. *ac. gls.*, larger accessory glands; *ac. gls'.*, smaller accessory glands; *ej. d.*, ejaculatory duct; *epd.*, epididymis; *tes.*, testis; *v. d.*, vas deferens.

PLATE XIII.

Fig. 9. A part of the pericardial diaphragm and one "alary" bundle of muscles. The unperforated part of diaphragm is median.

Fig. 10. A small piece of lateral perforated part of diaphragm highly magnified.

Fig. 11. Median vertical section of posterior part of male abdomen. *ac. gls.*, accessory glands; *an.*, anus; *cer.*, cercus; *ej. d.*, ejaculatory duct; *g. c.*, genital chamber; *pen.*, penis; *pod. pl.*, podical plate; *r.*, serrated rod above penis; *rect.*, rectum; *sa. pl.*, suranal plate; *s. p.*, spermatic pouch; *X t.*, tenth tergum; *IX s.*, ninth sternum.

Fig. 12. Ventral view of dorsal body-wall with diaphragm and tracheæ attached. *ao.*, aorta; *dp.*, diaphragm; *dp. m.*, fan-shaped muscle bundles ("alary" muscles) of diaphragm; *d. l. tr.*, dorsal longitudinal trachea; *ht.*, heart; *t. tr.*, transverse tracheæ.

Fig. 13. Alimentary canal, left side. *cr.*, crop; *gas. c.*, gastric cæca; *mal. t.*, Malpighian tubules; *œ.*, œsophagus; *rect.*, rectum; *vent.*, ventriculus.

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NEW NOCTUIDS FOR 1903. NO. 5.*

BY JOHN B. SMITH, SC.D.

Luperina migrata, sp. nov.

Ground color fuscous brown, shaded with smoky and marked with black. Head darker in front, immaculate, collar with a median, black transverse line below which it is paler. Disc of thorax palest, the sides of the patagia smoky; tufting small and neatly marked. Two or three small dorsal tufts of the abdomen evident. The primaries are strigate in appearance, and the transverse maculation is all lengthily dentate. There is a black basal streak and a black streak along the inner margin near base, extending to the t. a. line. The t. a. line is marked by a pair of oblique smoky streaks on the costa, and by a black dent on vein 1; in the submedian interspace it merges into a claviform that is black-edged and extends to the t. p. line. T. p. line geminate, smoky, the included space paler, even and evenly curved to opposite the cell, then inwardly oblique, strongly dentate, the inner portion becoming black as it approaches its lower termination; a blackish shading extends over the junction with the claviform. S. t. line slender, pale, dentate, broken, with difficulty traceable through a series of black or blackish interspaceal streaks. A pale ray extends from the t. p. line to outer margin over veins 3 and 6. There is a narrow black terminal line at the base of the slightly scalloped fringes, which are brown, marked with a conspicuous yellowish dot at the end of each vein. There is a diffuse smoky or blackish median shade, oblique from costa between the ordinary spots, then inwardly oblique, less marked, parallel to the t. p. line. The orbicular is elongate, narrow, oblique, black bordered and narrowly pale ringed. Reniform large, upright, kidney-shaped, pale ringed, partly edged with black scales. Secondaries soiled white at the base, the veins smoky, with a moderate deep smoky outer border: a blackish lunate terminal line at the base of the whitish fringes. Beneath, primaries gray, blackish powdered, with a distinct discal spot, an extramedian line and a series of dark terminal lunules. Secondaries whitish with a gray powdery border along the costa and outer margin, a small discal lunule and a distinct extramedian line. Expands 1.70–1.80 inches = 42–45 mm.

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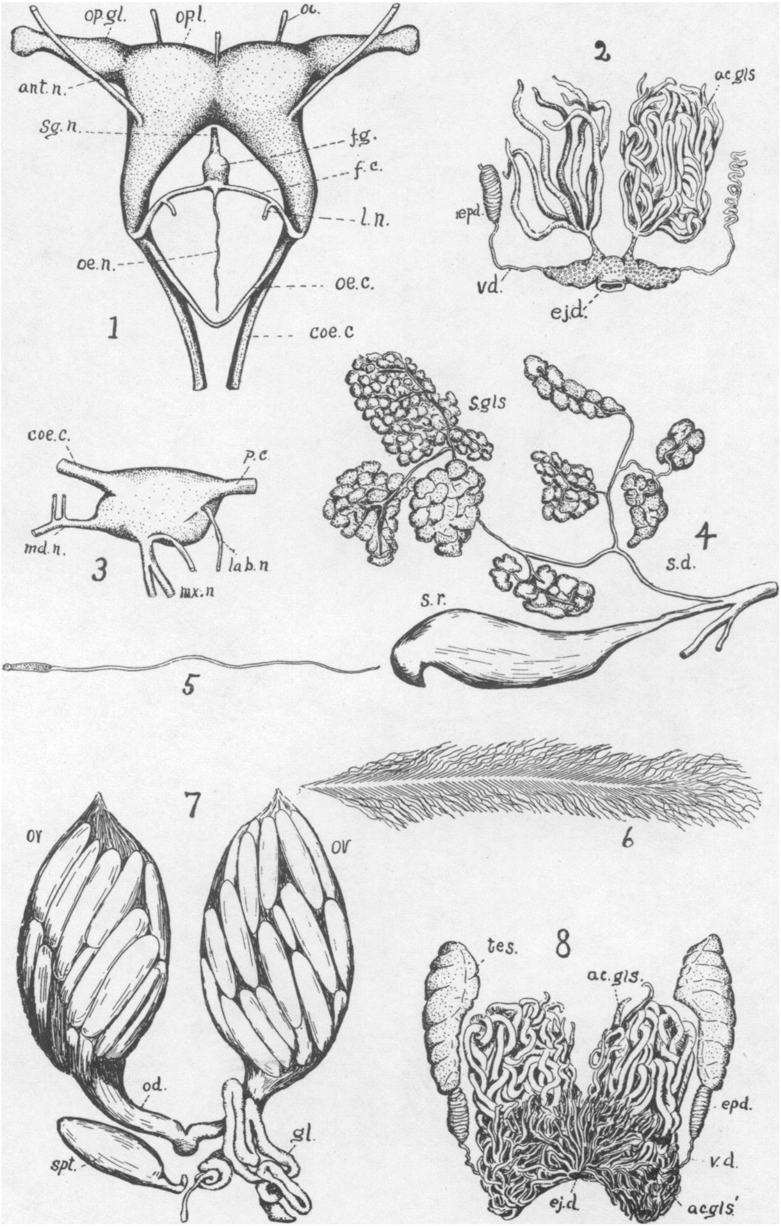
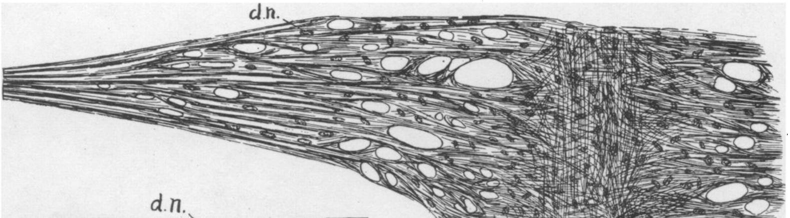
* The fourth paper of this series, containing references to those preceding is in the Trans. Am. Ent. Soc., XXIX, 191–224.



Internal Anatomy of Peranabrus scabricollis.



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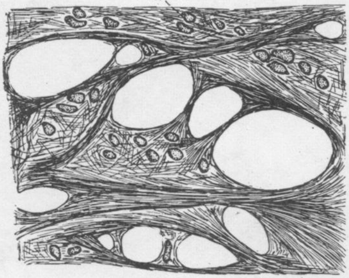

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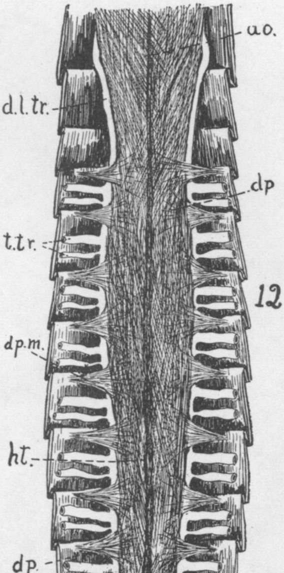

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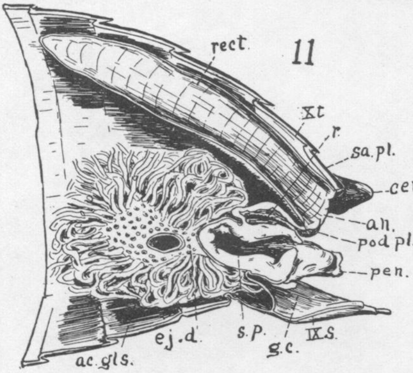

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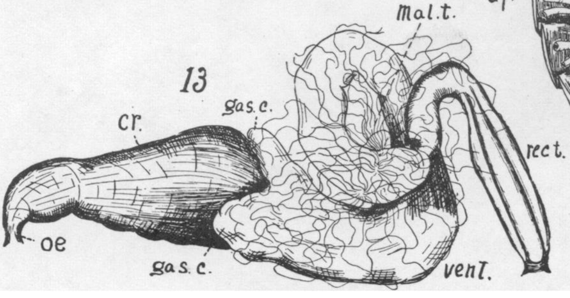

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Internal Anatomy of Peranabrus scabricollis.